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Analysis of Intensity of Weathering on Detrital Sediments of Gadilam River, Tamil Nadu, India

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Abstract:
Intensity of weathering can be measured by means of various indices and there is no strict scale of measure due to various factors involved in this process. Each and every index has its own merits and demerits like consideration of Mechanical agencies, Chemical processes or both. The oxidation state of iron in a weathering profile is influenced by the interaction between rock and groundwater. Clay Minerals, Carbonates and Oxidation of Iron content present in the detrital grains is the indicator of weathering during transportation and deposition. The presence of clay, Carbonates and Fe content in the upstream of Gadilam River basin are more and are declining towards the Beach. Common Quartz/Feldspar index, Resistant Minerals Zircon/Tourmaline index and less Resistant Mineral Amphibole /pyroxene Index are exhibiting influence of additional sources in the beach in addition with the river contribution. The USGS Sedimentological Tool, Geostatistical analysis, CM pattern and Visher's diagram also supplement such probabilities.

Keywords: *Gadilam River, GIS & Geostatistics, Sedimentology*

1. Introduction

The Gadilam River Basin extends from 79º1′38″E to 79º41′46″E longitude and 11º30′14″N to 12º0′20″N latitude (Topo Index 58M/1-14), bound by the Pennaiyar Basin in the north and Vellar basin in the south (Fig-1). The total length of the river is 156.90 km and it has been divided into upstream, midstream and downstream, parts for geology, slope, relief, etc.

2. Weathering

Weathering process involves physical disaggregation and chemical decomposition that change original minerals to clay minerals. Weathering formation include the Geology, drainage, slope, the ratio of water to rock, the temperature, the presence of organisms and organic material, and the amount of time. The types of clay minerals, Carbonates and Iron alteration found in sediments control how the weathered rock behaves under various transportation and deposition conditions.

Intensity of weathering can be measured by means of various indices like chemical leaching index (CLI), chemical weathering product index (CWPI), total chemical weathering index (TCWI), Chemical Index of Alteration (CIA), Chemical Index of Weathering (CIW), Plagioclase Index of Alteration (PIA), Vogt's Residual Index (V), Parker index, (Parker 1970), lixiviation index (Rocha Fillno et al. 1985), mobiles index (Irfan 1996), mobility index (Guan et al. 2001), Product index (Reiche 1943). Each and every index has its own merits and demerits like consideration of Mechanical, Chemical or both processes. The iron content in sediments as stain is influenced by the interaction between rock and groundwater during transportation and deposition.

3. Methods of Study

Sediment samples were collected from up-stream to the beach at an interval of 9km. Total 33 samples at 19 locations along the river and 5 samples at either side of the beach where the river debouches into the sea were collected (Fig – 1). The host rock samples were also collected to compare the mineral assemblages. In order to understand the relation of the distribution of sediments with the Geology, drainage pattern and understand the deposition of samples along the course of the river, the drainage pattern (Fig -2) and Geology (Fig 3) are also provided.

After coning and quartering, approximately 50gm of each sample was taken and washed. During washing, samples have been initially stirred the separated turbid water is decanted after giving 2 minutes of setting time. It is repeated until clear water is noticed even after giving the due setting time. If necessary, rubbing the sands with hand has also been done. Immediately after the last decantation the sands are kept for drying. Dried sands have been weighted to know the weight loss due to the removal of clays from sediments. To confirm that the particles are finally dissociated with individual grains they have been placed on a large sheet of glazed paper and examined with hand lens. If some aggregates are noticed those aggregates are crushed manually. The crushed sample has been treated with dil 1:1 HCL to dissolve the calcareous materials distributed in the sediments. Then the sample has been dried in hot air oven after proper washing. The weight loss in the weight taken is noted down as the weight of carbonates. The samples with Iron coating are treated with stannous Chloride and dil. HNO_3 with slight warming. The samples are washed thoroughly and dried.

The loss of weight noticed as iron stain formed due to oxidation. The organic rich samples have been treated with 30% H_2O_2 by volume to remove organic matter. After cleaning with water, the weight is noted down to calculate weight loss due to organic matter. After Seiving with quarter phi interval, various fractions were subject to bromoform separation to get individual heavy and light mineral counting percentage.

4. Results and Discussion

The presence of Clay content, Carbonates and Fe content in the detrital sediments of Gadilam River Basin are given in Table -1 and Fig 4.

4.1. Clay Content

Materials having a particle size of less than 2 micrometers and the family of minerals that has mixtures of finer grained minerals such as quartz, carbonate and metals are considered to be Clays. Clays and clay minerals are critical components of both ancient and modern sedimentary environments. Extensive alteration of rocks can produce clay minerals where rocks are in contact with water, air or steam that mostly prevails in the boulders on a hillside.

The transport and deposition of clays and clay minerals produced by eroding continental rocks and soils are important parts of sedimentary formations of fluvial environment. Silicate materials such as quartz, feldspars and amphiboles, carbonates, oxides and primary clay minerals, are transformed during transportation mainly by erosion, alteration and recrystalization during diagenesis. In the Upstream sediments the presence of clay content varies from 13.47% at KDY, 10.14% at IYR and gradually decreases towards the Midstream side as 6.80 at KVR, GKP, KPM, and PNT and still the clay content reduced to 3.47 at CMR, CMC, etc (Fig 4). Due to winnowing action of Beach environment the clay content is found to be negligible as 0.13%. The addition of clay content noticed in the mid-stream indicates the confluence of tributaries and the flood plain sediments of paleo-channels.

Carbonates

The Presence of carbonates in the sediments almost agree with the quantity of clay. The host rock intensively weathered Hornblende Biotite gneiss present in the Upstream is the main source of contribution of Carbonates, i.e. at IYR and PLK it goes upto 10.20%. The Lower part of Mid-stream like VSR and MLR shows 0.05% and 0.72%, Down Stream and Beach sediments shows very meager quantity of Carbonates 0.30 to 1.60% due to washing along the transit to beach.

Iron content

Hornblende Biotite gneiss present in the IYR and KDY exhibits 5.03% and 2.42% of Fe content and the paleo-channel flood plain sediments of MLR also exhibits 4.18% Fe content whereas in all the other locations the Fe content is very less around 0.1%. This indicates the Oxidation of Fe content is maximum in the in-situ sediments of Upstream and lateritized paleo-channel flood plain sediments.

Based on the clay mineral content, carbonates and Fe content weightage has been assigned and the same has been plotted in the GIS environment (Fig 6). The removal of clay and carbonates has been noticed in the downstream and beach sediments.

5. Weathering Indices

Common Quartz/Feldspar index, Resistant Minerals Zircon/Tourmaline index and Less Resistant Mineral Amphibole /pyroxene Index are commonly applying parameters to decipher the weathering intensity. The Gadilan river sediments shows 1.18 to 1.25 Qz/Fd index in the upstream, 1.34 to 1.6 in the midstream, 1.68 to 1.95 in the downstream whereas 1.71 to 2.41 in the Beach. Zr/Tour Index reveals that the there is a gradual increase from 6.40 in the upstream to 52.55 in the midstream but declining towards downstream and beach. The devoid of Tourmaline in few locations of downstream and beach sediments indicates that there is a complete washing out or susceptibility to weathering during the transit. The Amph/pyr Index is also supporting the fact that the alteration of pyroxenes from upstream to midstream increases the index from 0.96 to 12.13 and the absence of pyroxenes in the downstream and beach converts the index to infinite values. From these indices the fact ascribed the additional source contribution in the beach environment rather than that of riverine sediments.

6. Conclusion

So it can be surmised that, the population other than river sediments of almost of different sediments, are being added to the beach. The Clay mineral, Carbonates, Fe content, heavy and light mineral indices have clearly attested to characteristic differences in the weathering of the river sediments and the beach sediments. The aforesaid results evidence that the beach sediments are entirely different from those of the river sediments; they may have been derived from the offshore as well as the coastal relict deposits. The removal of Clay mineral and Carbonates has shown in GIS platform that indicates the downstream and beach wash of finer particles from the sediments.

7. References

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ANNEXURE

Location	Clay	Carbonate	Fe Content	Region
KDY	15.1	4.48	2.42	UPStream
IYR	7.53	10.2	5.03	UPStream
KVR	17	2.9	0.28	UPStream
AGK	2.57	4.6	0.12	UPStream
PLK	1.05	10.2	0.33	UPStream
PPM	2.36	3.25	0.13	UPStream
GKP	9.13	1.18	0.82	UPStream
VPM-I	0.43	3.33	1.62	UPStream
VPM-II	0.33	3.07	0.27	UPStream
CMR	2.08	2.38	0.15	MidStream
CMC	3.92	6.48	2.72	MidStream
VSR	0.12	0.05	0.04	MidStream
MLR	2.57	0.72	4.18	MidStream
SMD	3.53	3.47	0.18	MidStream
PNT	4.93	4.98	0.38	MidStream
NMD	0.77	3.33	0.1	DownStream
KPM	6.7	3.42	0.62	DownStream
TVP	0.25	0.83	0.17	DownStream
KMP	2.22	0.3	0.22	DownStream
AKR	0.47	0.87	0.3	Beach
DVPSE	1.45	1.6	0.12	Beach
DVPHT1	0.42	0.85	0.05	Beach
DVPNE	0.23	0.77	0.08	Beach
DVPHT2	0.43	0.97	0.17	Beach

Table 1: Clay, Carbonate and Fe content in detrital grains of Gadilam River (in %)

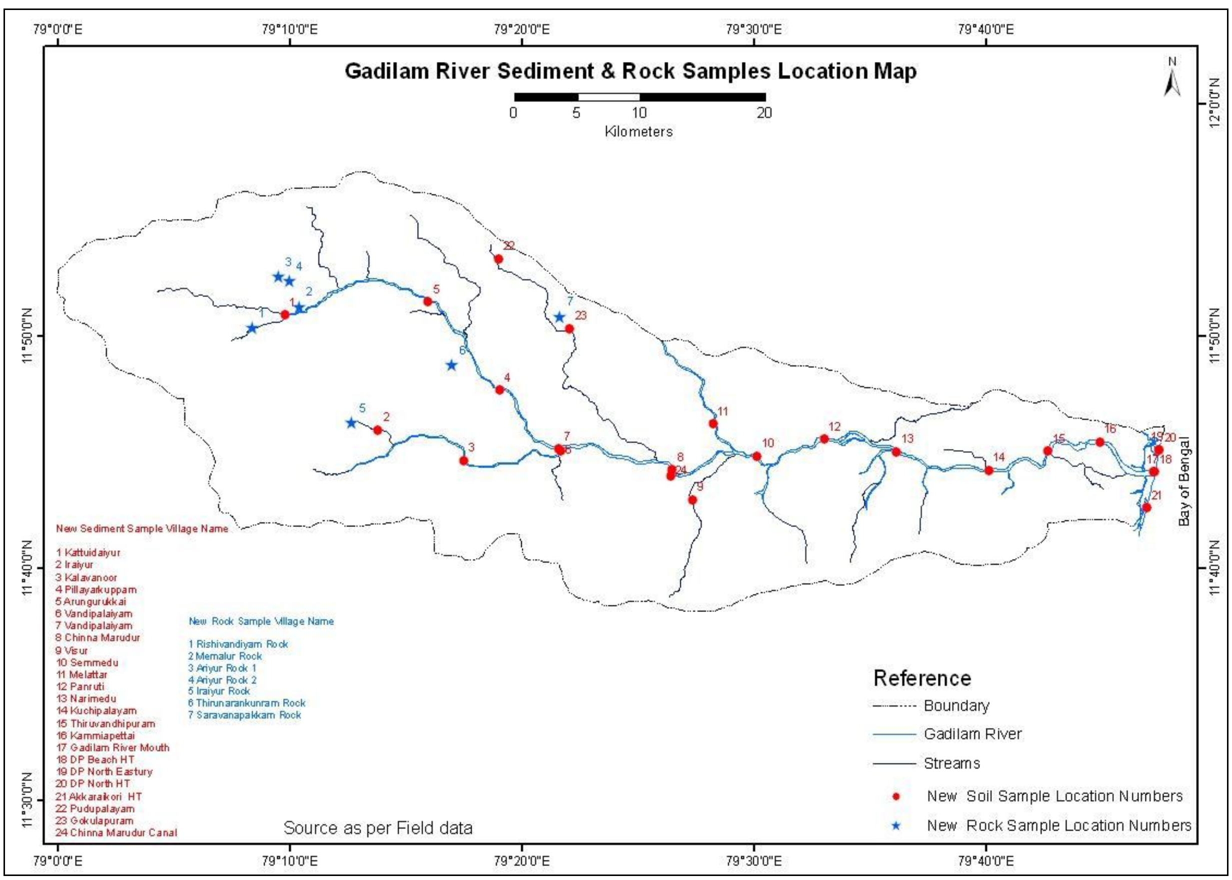

Figure 1: Gadilam River Basin Sample Location Map

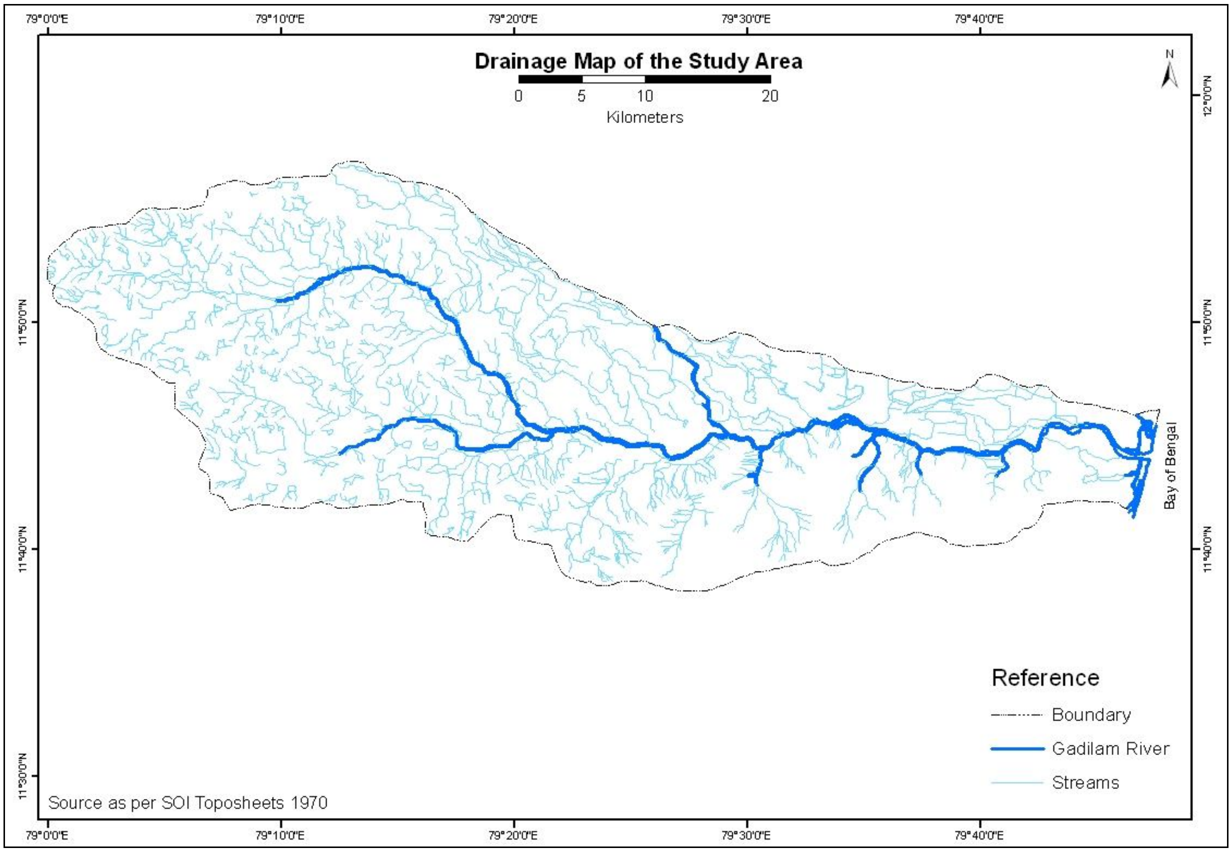

Figure 2: Gadilam River Basin Drainage Map

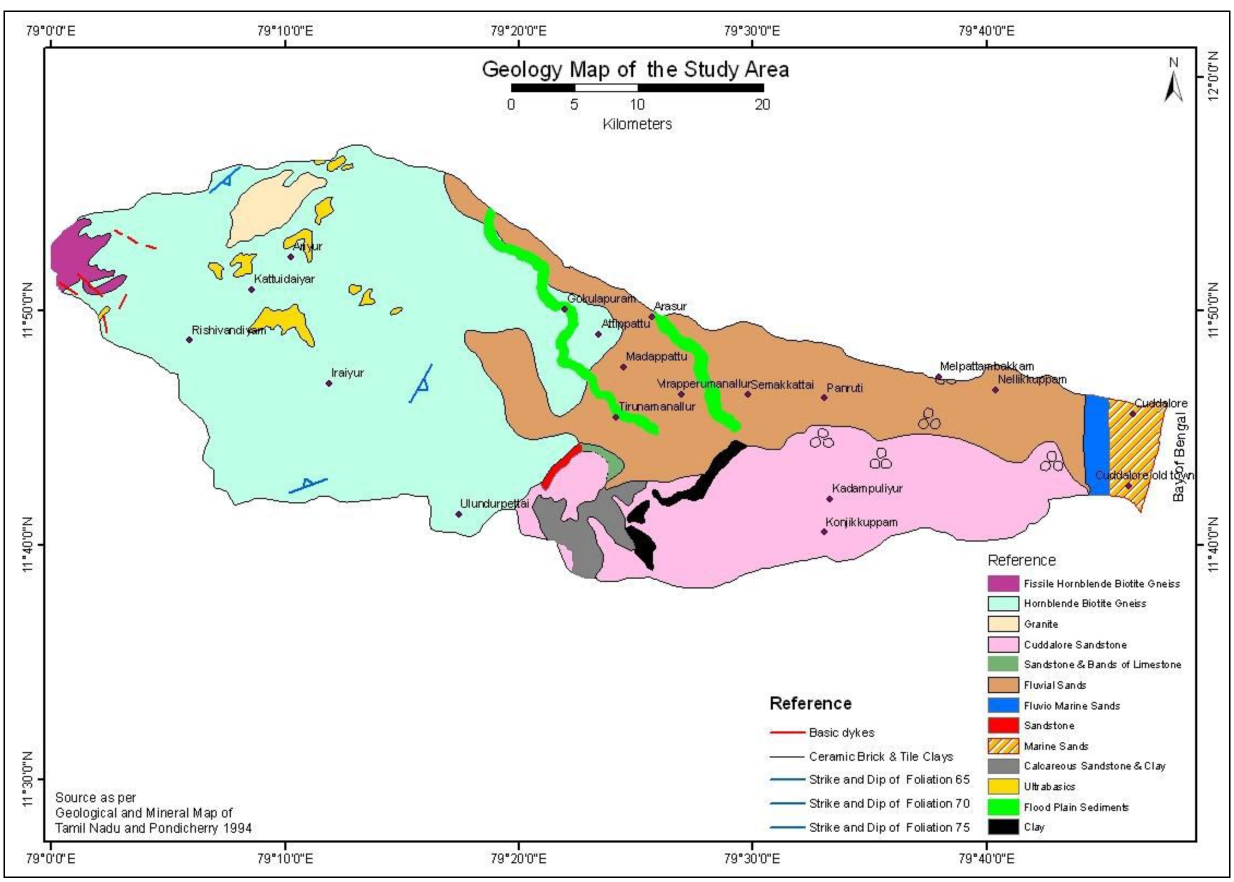

Figure 3: Gadilam River Basin Geology Map

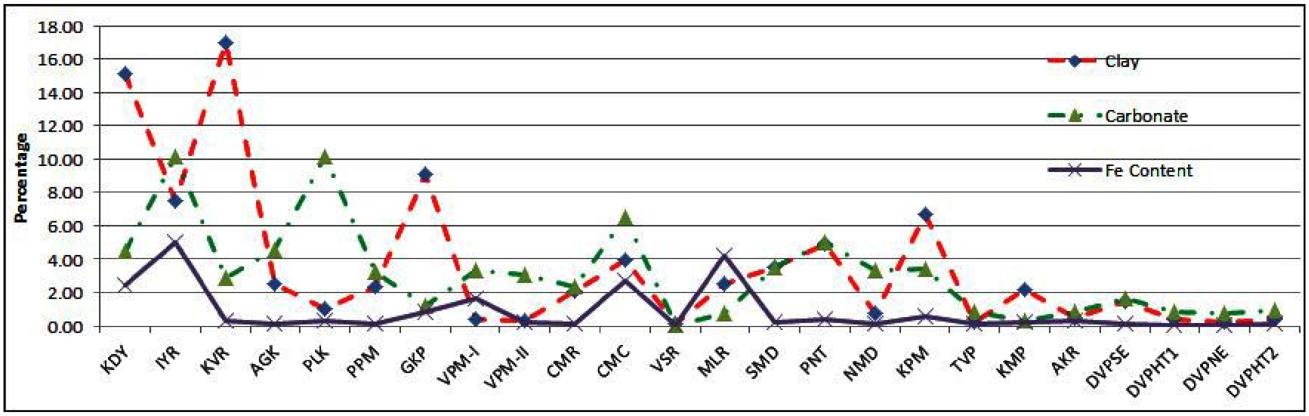

Figure 4: Clay, Carbonate and Fe contents in detrital grains of Gadilam River Basin

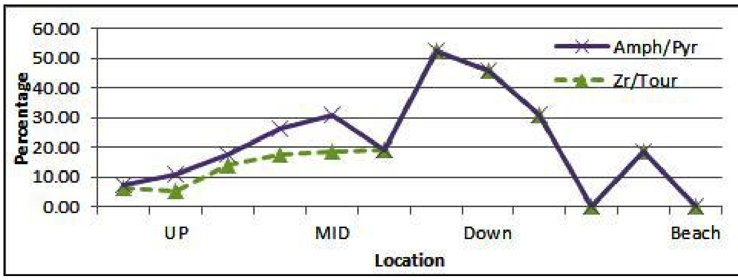

Figure 5a: Heavy Mineral Indices

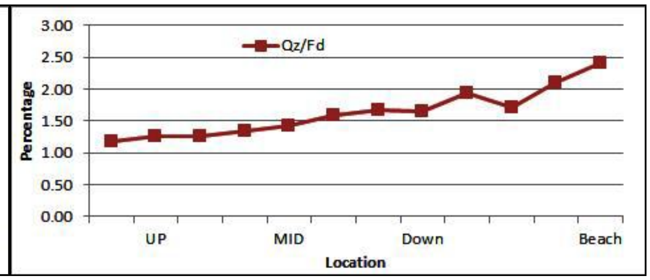

Figure 5b: Light Mineral index Qz/Feld

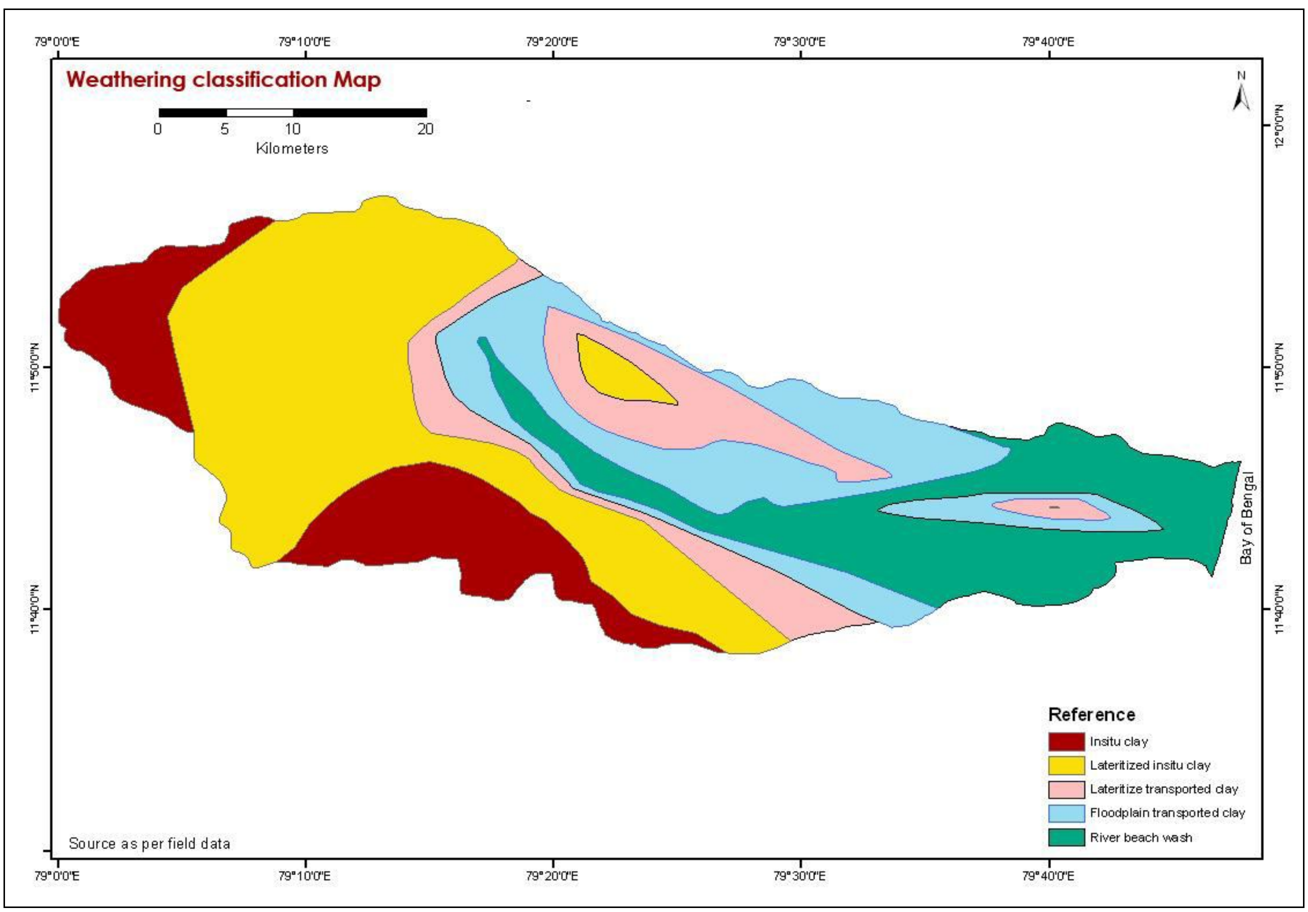

Figure 6: Classification of weathering occurred in the detrital grains of Gadilam River Basin